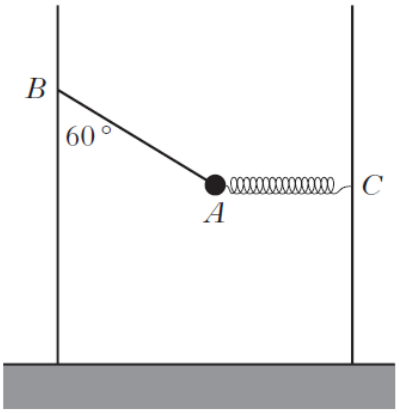
Hooke's Law & Equilbrium

2012

A4. A particle of mass 1 kg is held in equilibrium by a light, inextensible string AB and a light spring AC. AC is horizontal and AB is inclined at $60°$ to the vertical, as shown in the diagram.

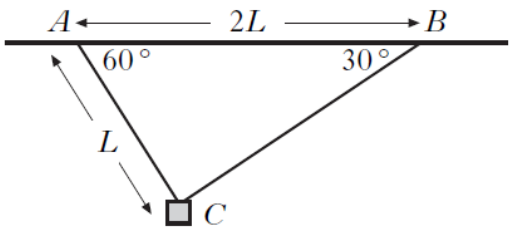


(*a*) Show that the tension in the string AB is $2g$ newtons and calculate the tension in the spring AC. **3**

(*b*) The spring has modulus of elasticity 40 newtons and natural length 10 centimetres. Calculate the distance AC. **2**

2009

A9. A small block of weight W newtons is suspended in equilibrium from a horizontal ceiling by two strings AC and BC as shown in the diagram where $\angle BAC = 60°$ and $\angle ABC = 30°$.



The distance between A and B is $2L$ metres and the string AC has length L metres.

(*a*) Show that the magnitude of the tension in string BC is $0{\cdot}5\,W$ newtons. **4**

(*b*) The string BC is elastic with natural length L metres. Calculate the modulus of elasticity of BC and show that the elastic potential energy stored in the string is $\frac{1}{4}(\sqrt{3}-1)LW$ joules. **5**

Hooke's Law & Energy

2005

A8. A bungee jumper of mass m kg falls vertically from rest from a high bridge. One end of an elastic rope is attached to the jumper, the other end to the bridge at the point where the jumper commences her fall. The natural length of the rope is l metres and the modulus of elasticity is $12mg$ newtons.

At the moment when the jumper is brought instantaneously to rest by the rope, the extension of the rope is a metres.

(a) Neglecting the effect of air resistance, use conservation of energy to show that the extension satisfies

$$6a^2 - la - l^2 = 0.$$ **3**

(b) Hence find, in terms of l, the distance the jumper falls before first coming instantaneously to rest. **3**

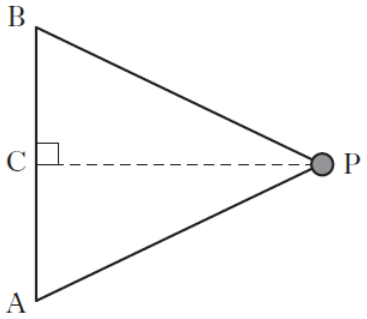
2015

A3. A catapult consists of an elastic string of natural length 40 cm and modulus of elasticity 25 N. One end of the string is fixed to A and the other to B, with AB of length 20 centimetres.

A particle of mass 20 g is held in the middle of the string and the string pulled back to P.

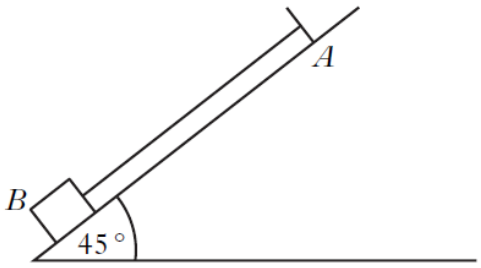
It is held at rest with PC of length 24 centimetres. A, B, P and C all lie on the same horizontal plane. The particle is then released.

Find the speed with which it passes through C. **5**



2010

A8. A block of mass 2 kg is held at rest on a rough slope inclined at an angle of 45° to the horizontal. A light spring has one end fixed at a point A and the other end is attached to the block, B. The natural length of the spring is 1 metre and its elastic modulus is λ newtons. The initial distance between A and B is 2 metres and the coefficient of friction between the block and the plane is μ.



The mass is released and travels 25 centimetres up the slope in a straight line before coming to rest. Show that

$$\lambda = \frac{8\sqrt{2}}{7}(1+\mu)g.$$ **6**